CLARKE (E.C.)

COMMON DEFECTS

IN

HOUSE-DRAINS.

BY

ELIOT C. CLARKE, C.E.,

PRINCIPAL ASSISTANT ENGINEER IN CHARGE OF IMPROVED SEWERAGE WORK, BOSTON, MASS.

BOSTON:
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1879.

[From the Tenth Annual Report of the State Board of Health.]

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COMMON DEFECTS IN HOUSE-DRAINS.

THE purpose of this paper is to state what are the common defects in house-drains, and to show the usual forms and condition of such drains as they exist in our cities and towns to-day. The statement is chiefly based on observations made in Boston while constructing intercepting sewers; but it is assumed that examinations in other cities and towns of the Commonwealth would reveal a condition certainly no better, and probably worse. Some testimony will be offered from those whose occupation has given them opportunities for observation; and, while it is not intended to cite exceptional cases of defective arrangement or construction, a few characteristic examples will be given, such as investigation would prove to be very common.

What are the essential conditions of an efficient house-drain, one or more of which must be violated to constitute a defect?

Briefly stated, they are, that the drain must be of size and shape to concentrate its flow, smooth inside, suitably inclined, tight, properly connected with the house-pipes and sewer, strong and durable in material. It is of great importance that the portion of the drain within the house should be always in such a position as to admit of ready inspection at any time; it *should be in sight*,[1] and not concealed. Let us see what proportion of Boston drains reasonably fulfil these conditions.

Existence is perhaps the most essential condition of a drain; and, by an Hibernicism, non-existence may be termed its most serious defect. Naturally non-existence was not

[1] The same rule applies, of course, to soil-pipes, although that part of the subject does not come within the scope of the present inquiry.

observed in digging for the intercepting sewers, but there is sufficient evidence that it is not unknown.

The writer has seen a case where a drain-pipe from a dwelling ran through the walls, and there ended: several similar cases have been reported to him; and another, where a block of six expensive houses, occupied for months with all the customary apparatus in the way of plumbing and waste-pipes in full operation, had no drains beyond the walls to the street-sewer. Such cases are rare, and generally reveal themselves quickly; but it is more common to find drains which are so solidly filled with earth, grease, and other matter, as to exist only in name, and which, for any good they accomplish, might just as well not exist at all. One, examined by the writer some months since, had apparently had nothing through it for years, the whole waste from the soil-

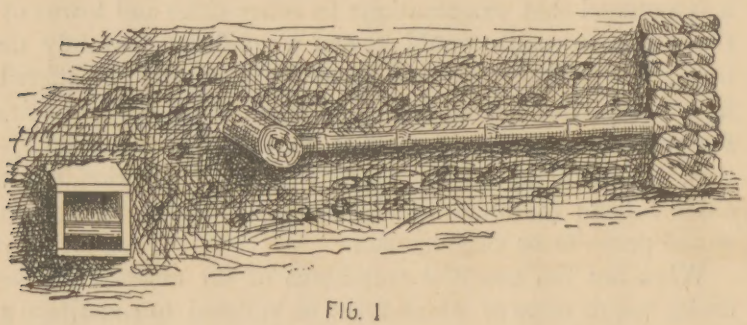

FIG. 1

pipe having accumulated beneath the cellar-floor. The same state of things was lately found to exist below the Rockland Bank Building in Boston. A case has been mentioned to the writer where it is thought that three deaths can be directly traced to the stoppage of a drain which was so clogged as not to act. Almost every one who has been led into this line of inquiry has some similar instance to relate, and evidence could be multiplied indefinitely. Of the house-drains crossing the intercepting-sewer trench, during its construction last season, fully twenty-five per cent were almost or entirely choked with sludge.

An example of *semi*-existence, observed while digging for the sewer in Charles Street, is worth noting, as showing the intelligent judgment sometimes exercised in doing this kind of work. It will be understood by referring to the sketch

(Fig. 1). The drain was one for surface-water; and the drain-layer, in digging from the house towards the sewer, came upon a log lying across his trench, and here stopped short, chopped a hole in the log, found it hollow, and connected his drain to it without going farther. It is true, the log led to no outlet, but then it saved trouble — to the drain-layer.

As to the question of size of drains, it was found that of 113 observed while building sewers the past year, —

11	were about	4	inches	in	diameter.
4	"	" 5	"		"
21	"	" 6	"		"
5	"	" 7	"		"
27	"	" 8	"		"
8	"	" 9	"		"
11	"	" 10	"		"
26	"	" 12	"	or over	"

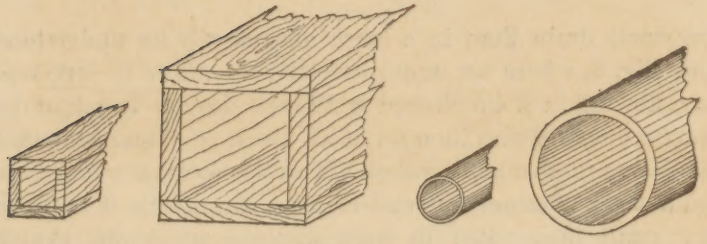

FIG. 2

The sketch above (Fig. 2) illustrates the wide range of this diversity. Most of them drained single dwellings similarly situated; and if the small ones were large enough the others must have been unnecessarily large, and *vice versa*.

But what is the proper size?

Probably nine engineers out of ten would answer, "By no means larger than 6 inches;" and nine drain-layers out of ten would now say, "Never smaller than 8 inches." The former argue that the drain need only be large enough to pass through it all that it can reasonably be expected to carry, and that any thing beyond this tends to make the ordinary flow spread thinly over a broad bottom, without sufficient depth to carry solid matters along with it. The latter reply, that, in fact, a drain never does receive only what can reasonably be expected; and that, the larger the

drain, the more storage-room for the unreasonable accumulations of clothing, tin and glass ware, dead animals, etc., usually found in it. "In practice," say they, "large drains take longer to choke up than small ones, and are therefore better."

Their facts are correct, but their conclusions may be doubted. In building a drain, the object should be to prevent the *beginning* of a deposit; and this is much easier

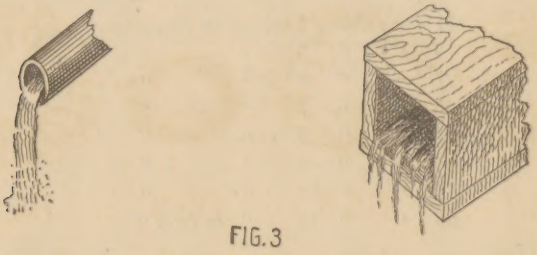

FIG. 3

in a small drain than in a large one, as will be understood from Fig. 3, where an equal quantity of water is supposed to be flowing in a 4-inch and a 12-inch drain. It might be thought (by one who thought at all about such matters) that the discharge of a great volume of water, as from a bath-tub, would tend to scour out and clean a drain. So it might a very small one. But in such a structure as our sketch

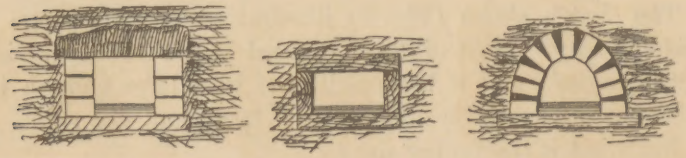

FIG. 4 FIG. 5 FIG. 6

represents, with a flat bottom 12 inches wide, the stream caused by such a discharge would probably meander over the bottom of the drain, and be nowhere over a quarter of an inch deep. Let a deposit once begin, and subsequent accretions as surely choke a large drain as a small one, only it takes longer to do it. And it may even be questioned whether it is an advantage to be able to use for an additional year a drain nearly full of putrescent filth, or whether it is

not better to have the evil disclosed and remedied as soon as possible. It may safely be said that three-quarters at least of the house-drains in Boston are too large, because, even if some of them perform efficient service, small ones would do as well, and be less liable to get out of order.

In respect to form, there is almost as much diversity as there is in size. Figs. 4 to 10 give the more common shapes.

The first three must be condemned at once, on account of

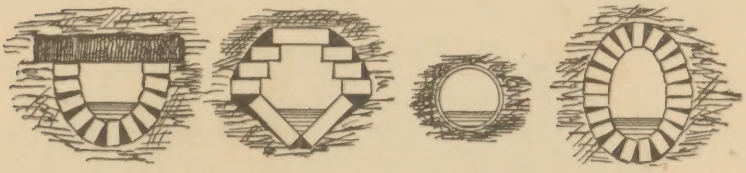

FIG. 7 FIG. 8 FIG. 9 FIG. 10

their flat bottoms. The water passing through them spreads out into a thin sheet, which does not readily wash along solid matters. Floating matters also tend to stick in the angular corners more than than they would on rounded surfaces. That this is so, is shown by the record. Of the 113 house-drains whose condition was noted, 45 were constructed with flat bottoms; and of these, 26 were choked, or nearly so, with sludge; 19 were reasonably clean. Of the remaining 68, which

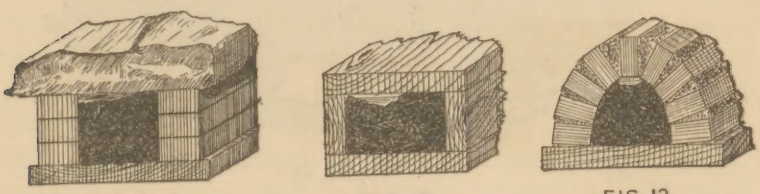

FIG. 11 FIG. 12 FIG. 13

had rounding bottoms, 12 were full, or partly so, of sludge; 56 were reasonably clean. The common appearance of these flat-bottomed drains, as they were uncovered, is shown in Figs. 11, 12, and 13. Fig. 13 represents the condition of a drain, now disused, which came from the City Hospital grounds.

The shapes shown in Figs. 7, 8, 9, and 10 are unobjectionable, although, in fact, these drains were often too large, and

had other defects. Fig. 8 is a kind of construction which was in vogue twenty-five years ago; and except for liability to open joints, its angular bottom, and its size, is passably good. Our facts seem to show that forty per cent of the Boston house-drains are defective in shape.

A drain should be smooth, so as to afford no prominences for solid particles to lodge upon. Planed wood, slate, and brick are smooth enough. In use they soon become covered with a film of slime that makes them very slippery. Un-

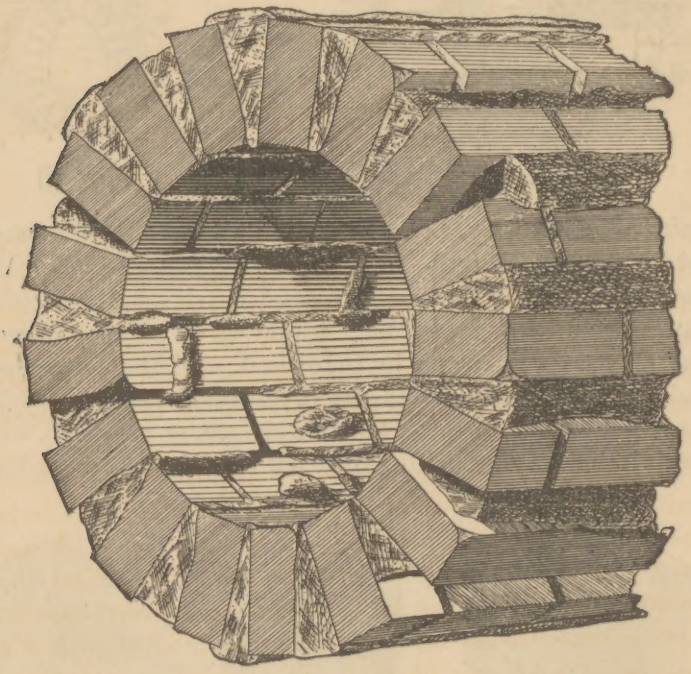

FIG. 14

planed wood, which until recently has been somewhat used, is apt to be rough, and to have splinters pointing against the flow, which catch solids moving upon them. The chief difficulty in making a brick drain smooth is the care required to see that no mortar is left projecting into the drain. Fig. 14 shows the manner in which such work is often finished.

It is possible to strike each joint of the lower half of the drain so as to leave a reasonably smooth surface; but a difficulty harder to avoid is caused by portions of the mortar

uniting the arch-bricks, falling when the supporting centres are removed. These lumps of cement, indicated in the sketch, adhere to the bottom, and, unless carefully scraped off, harden, and form serious obstructions to the flow of sewage.

Pipe drains, whether cement, clay, or iron, are smoother than those of brick. Glazed clay pipes are especially smooth. In these, however, it is very common to find the mortar uniting the several sections of pipe projecting into the interior, forming a series of little dams which obstruct the flow. Fig. 15 illustrates this. This can be avoided by carefully cleaning the interior of each pipe, after laying it, with a swab or hoe; a simple precaution, but often neglected by a careless drain-layer. It will not be an exaggeration to say that three-quarters of existing drains are defective as to their smoothness.

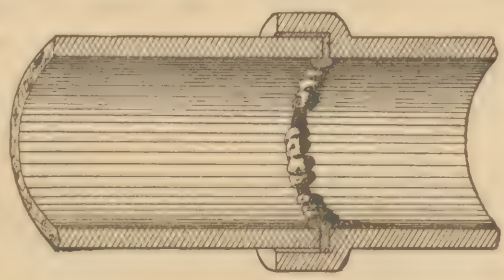

FIG. 15

The best rule in practice for the inclination of a house-drain is to give it as much pitch as is possible; and in few cases is less than one-half inch to the foot safe. A great many drains are faulty in this respect. The actual inclination of drains crossing the trench of the intercepting sewer the past year was not taken; but, of the 113 met with, 9 are recorded as level, and 14 as pitching the wrong way, that is, towards the house. One of these, coming from a public-school building, was about 7 inches lower at the street curb-stone than at the sewer. The condition of such a drain is shown in Fig. 16.

The water stands in the depressed portion of the drain to the height of its connection with the sewer; and, having little motion, deposits are apt to occur. In the case referred to, it is but fair to say that the school-drain was clean so far as seen. Very possibly an abundant use of water or recent heavy rains had scoured out any deposit that may have taken

place. It is probable that most of this inclination in the wrong direction occurs in the street, near the sewer. The drain-layer frequently begins to put in his drain simply with reference to the house, without inquiring what is the elevation of the sewer into which it is to empty. He digs his trench towards the street, and lays his drain on a slope which he judges by his eye to be sufficient. This in itself is a deceptive matter, as a trench generally seems to slope down towards the observer. When the sewer is reached, it is found to be higher than the portion of drain already laid. What is to be done? It is not the drain-layer's fault, that the sewer is too high; he cannot take the trouble to dig up his pipe again; it is only a few inches any way; and the pipe is run up and connected, the trench back filled, and, "out of sight, out of mind."

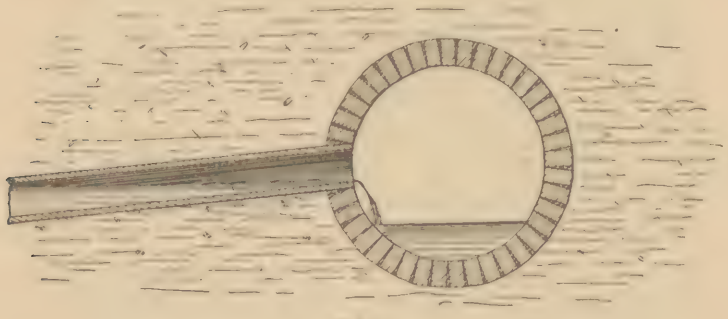

FIG. 16

It was stated that one of the essentials of an efficient house-drain is that it shall be tight. Mr. Ernest Bowditch has called the writer's attention to a condition in which, at first sight, a leaky drain might appear better than a tight one. He says, "It is sometimes noticed, where plumbing is from twenty to twenty-five years old, and where all the drains outside the cellar walls are of open stone (technically French drains), the soil-pipe not being ventilated, that there is no perceptible leakage of sewer-gas into the house. It is reasonable to suppose in these cases that the gas generated outside the house works up through the soil, rather than force the traps in the house. The modern method of tight drains and cesspools tends to drive all gases into the house. It is frequently more important, therefore, that recent plumbing should be ventilated, than that of older date."

Both tight and open drains tend to produce evils; but those arising from a tight drain can be obviated by proper ventilation of the house-pipes, while the evils from leaky ones are irremediable. Therefore we say, drains should be tight, that sewer-gas (or, what is worse, matters capable of producing sewer-gas during a long decomposition) may not escape; and also that the water may not leak out, leaving the solid contents of the drain stranded.

This want of tightness is the commonest defect of all, and probably three-quarters of the annoyance from drains is due to it. In the annual report of the Boston City Board of Health for the year ending April 30, 1878, is given the result of examinations of 351 house-drains in different sections of the city. Of these, 193, or 55 per cent, are reported as defective; and in nine cases out of ten the defect consisted in the drain not being tight. This defect, more than others, affects the better kind of houses.

Mr. Theodore Clark, who has had experience with this class of dwellings, speaks thus of earthenware and cement drain-pipes: "These, I think, rarely remain tight many years. Even where the drains are laid with the greatest care, I have observed that water will often, in course of time, make its way out around the joints between the pipe and the ring of cement. When broken it is found that the cement has taken a perfect mould of the pipe; but either from some greasiness, or possibly a little dust on the pipe at the time of laying, it has failed to adhere, and water has ultimately forced its way through. An accumulation of water caused by an obstruction in the pipes will often search out such places, which must have previously allowed gas to pass freely. Another very frequent source of trouble is the settling of the ground under and around the drain-pipes. In houses with drains originally in perfect condition, their joints will frequently in a year or two be found to be separated, the pipes cracked, or the branches settled away from the soil-pipes which enter them. In either case the drainage saturates the ground about the defective places with matter whose effluvium will penetrate even concrete.

"In my experience, defects of this kind are far more common than leaks in iron soil-pipes, imperfect traps, or other defects attributable to the plumber; and the earthen drain-

pipe should generally be first examined in searching for the cause of unpleasant smells in any part of the house, as effluvia originating in the cellar often find their way through furnace-pipes and behind furrings to the remotest corners of a building."

In this connection may be cited several cases recently reported, in each of which a smell was noticed whose source it seemed impossible to locate, until at last a leak was discovered in the drain, directly communicating with the cold-air supply-pipe of the furnace, which latter, of course, acted as a distributor of the gas through the entire house. A similar leak into the air-duct of the Boston City Hospital proved

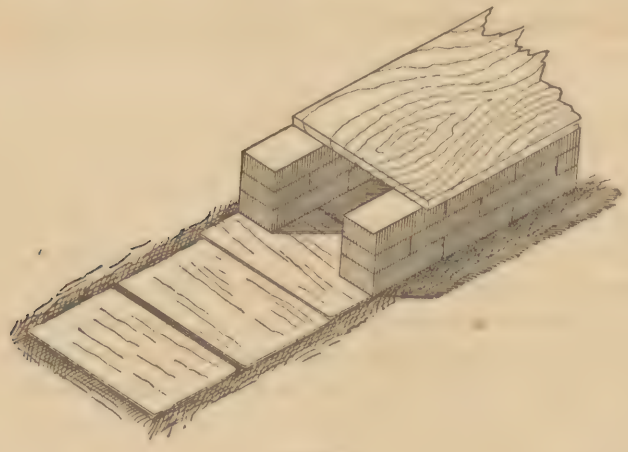

FIG. 17

a source of serious illness, and probably of increased mortality, among the surgical patients, until remedied in course of the various improvements introduced by Dr. Cowles.

Leaky drains are due to a variety of causes. In a brick drain the joints between the bricks may not be solidly filled with mortar, the mortar may not adhere to the bricks (a common result of not wetting the latter before laying), the bricks themselves may be shaky or rotten, or the structure as a whole may be broken by unequal settling. In some drains no attempt is made to have tight joints. A kind much built some years ago, and of which many examples remain, is shown in Fig. 17. In this the bottom is made of roofing-slates placed side by side, or sometimes overlapping,

but never with any thing to prevent water percolating through the joints into the soil below. Fig. 17 reversed, with plank below and slates above, would resemble more than half the drains on Beacon Hill as they were originally made, and still exist. A plank drain may leak through open joints, variously caused, through knot and nail holes, and by the rotting of the wood where it is not constantly wet. A pipe-drain may leak from bad joints, from flaws in the pipe itself, or because it has been broken. The breakage is generally

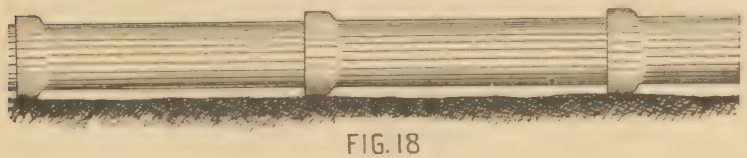

FIG. 18

due to unequal settling, sometimes to defective pipes, and occasionally to improper methods of laying them. The sections are sometimes carelessly or ignorantly laid on the bottom of the trench, resting merely upon their flanges as shown in Fig. 18, instead of upon their entire lengths, with depressions dug out for the flanges, as in Fig. 19.

In the former case, unless the dirt be rammed back beneath the pipe with unusual care, the pipe acts as a beam resting on supports three feet apart, and is liable to be broken by

FIG. 19

the superincumbent earth, or by any shock as of a body falling, or a wagon jolting over it.

As the greater proportion of leaks are caused by defective joints, it follows that a brick drain with joints every inch or two is more liable to this defect than a clay or cement pipe with joints two or three feet apart, and that iron pipe in five-feet lengths is less liable to it. A place where a leak frequently occurs, especially in a house built on made land, is where the drain passes through the cellar-wall. If the

foundation wall is supported, and the ground on either side settles, a condition of things is produced shown in Fig. 20.

A drain may exist in such a state for months, or longer, without detection. The water follows the wall, perhaps into neighboring houses, saturates the ground in the vicinity, and finally finds an outlet through some pervious stratum or into some well. If the cellar be concreted, little moisture may be apparent, — an ill-defined odor to which the family become accustomed, and about which visitors feel a delicacy of speaking, being the only suggestion of trouble, — until finally, perhaps, may come some "unaccountable" sickness, or "mysterious visitation of Providence." Mr. W. H. Bradley,

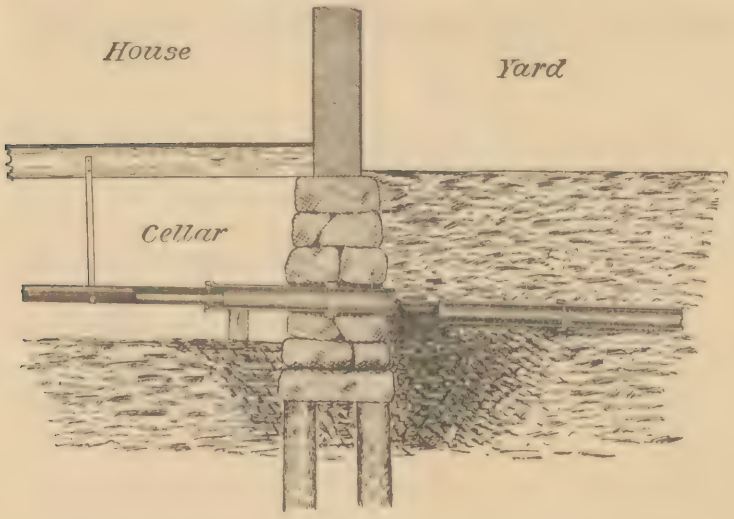

FIG 20

Superintendent of Boston Sewers, spoke thus of this matter three years ago, in a communication to the city government: "The number of drains leaking under houses and into foundation-walls is very large; it is almost certain to occur with every house upon made land, and is always neglected by owners and tenants till it becomes insupportable; and with sickness traceable to such causes, and continual discomfort prevailing, the parties most interested still wait for the city to carry out costly general measures, thinking thus to abate their private nuisance. As a rule, a bad smell in a house means something wrong locally, and should be stopped in a day."

The examinations of house-drains, before referred to, made by the Boston Board of Health, which aimed at the discovery of leaks by the use of strong-smelling volatile oils, show that more than one-half of Boston drains (and the proportion would probably not be less elsewhere in the State) are defective from want of tightness.

A drain should be firmly and properly connected to the sewer at one of its ends, and to the soil-pipe (if this connection be within the house, as it almost invariably is) at the other. More leaks probably occur at the latter place than at any other. The inspectors of the Boston Board of Health,

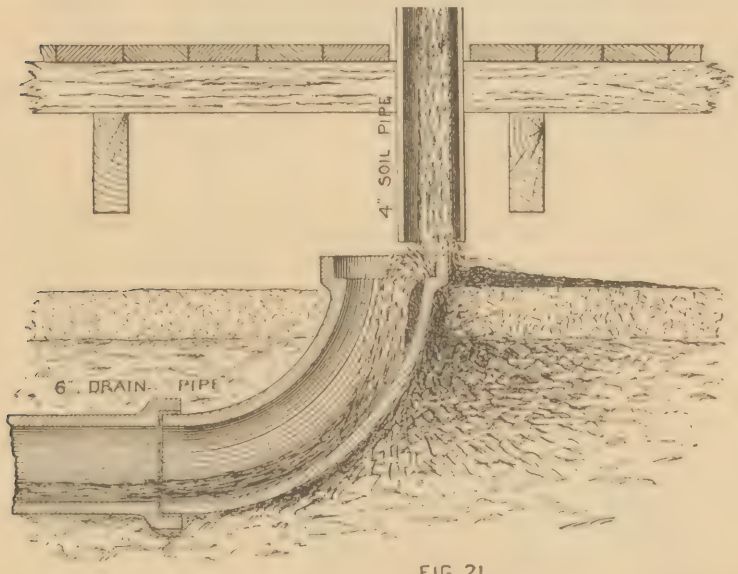

FIG. 21

after pouring a little oil of peppermint into an upper water-closet, most frequently recognize the familiar odor at this point. Sometimes there is not even a pretence of making a tight joint, the soil-pipe being merely inserted loosely into the drain. In other cases the joint, intended to be tight when made, through careless construction is not so; and again having been tight when made, it may have been injured since. Fig. 21 is from a sketch made by Mr. Bradley of a case brought to his attention, existing in the house of a Boston physician. The drain may settle away from the pipe, or the pipe may settle into the drain; an iron pipe by its

expansion and contraction may break the joint between them. So liable is this place to disturbance, that when possible it is well to build it so that it may be accessible to examination at any time when there is the least suspicion of wrong. Rats frequent drains, and dig into and out of them

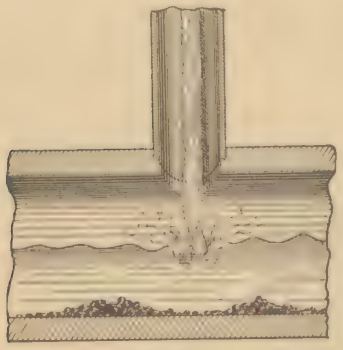

FIG. 22

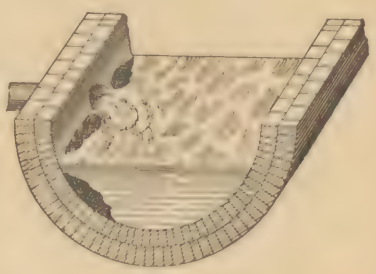

FIG. 23

with surprising facility. An influx of rats into a house should be taken as strong presumptive evidence of a defect in the drain.

The mode of connecting a drain with the sewer affects more the efficiency of the latter than it does directly the sanitary condition of the house. But as, indirectly, the condition of the sewer as to cleanliness, efficiency, and liability to generate gases, affects, through the drain, every house connecting with it, the proper junction of the drain and sewer deserves a degree of attention which till quite recently it has seldom received.

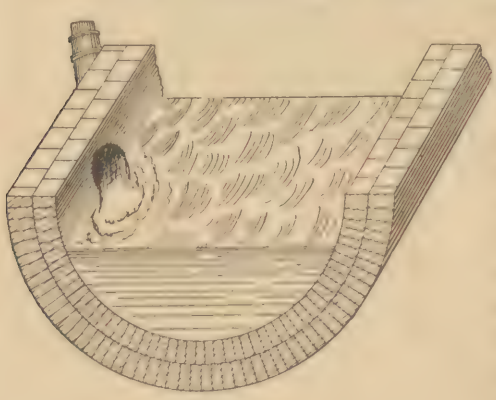

FIG. 24

A drain should enter the sewer either by a curve tangent to the direction of flow in the sewer, or at an acute angle with

that direction, so that the contents of the drain shall unite readily with that of the sewer, and the velocity of neither be much retarded. Nineteen out of twenty drains in Boston, built previous to 1876, enter the sewer at right angles. The effect of such an entrance from the top or side it is attempted

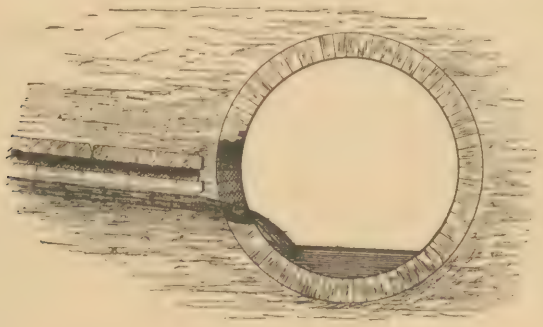

FIG. 25

to show in the accompanying sketches (Figs. 22 and 23), where the tendency to arrest the flow in both structures, and to cause eddies and deposits, is shown in a somewhat exaggerated way. Fig. 24 shows the better result attained by connecting the drain at an acute angle.

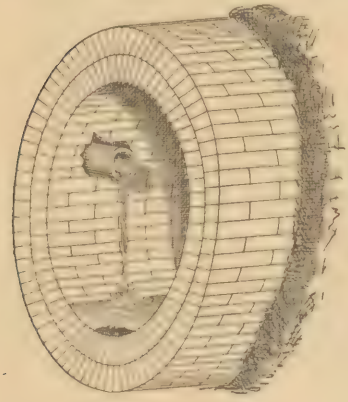

FIG. 26

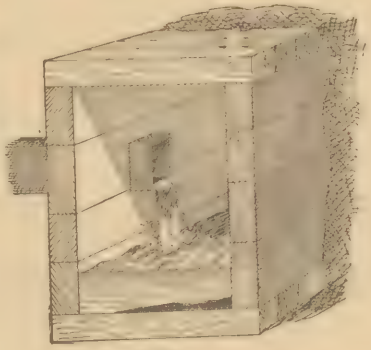

FIG. 27

It will probably be conceded, that, whatever may be the mode of connection between drain and sewer, it should be made in a firm and workmanlike manner. In practice it has generally been very loosely and roughly made. Sometimes there is no connection at all, as shown in Fig. 25, where

the drain is simply brought pretty near to the sewer, and a hole broken into the latter. Of course water from both drain and sewer soaks into the ground, and occasionally the earth falls into them. Often, as in Figs. 26 and 27, a hole, somewhat too large, is cut into the side of the sewer,

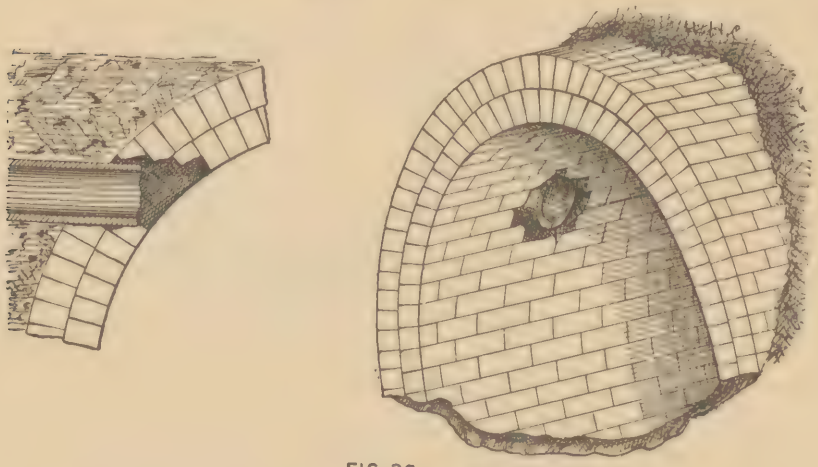

FIG. 28

and the pipe pushed through, and allowed to project more or less within the sewer. Fig. 28 shows the rough way in which pipes are often connected with the arch of a sewer.

The proper height in a sewer at which drains should be connected is about its ordinary flow-line. At this point the

FIG. 29

water from the drain mingles with that in the sewer with the least disturbance to both. In Boston, drains have commonly entered the sewers wherever they happened to run against them. As a general rule, they are too low (Fig. 29); and water from the sewer backs into them, making a sluggish

current. Their being too low might be expected from what was shown in connection with inclination of drains; and this results largely from an effort to drain cellars into a sewer higher than the cellar floors. Occasionally a drain-layer, having found a sewer much lower than he expected, has dug vertically to it, broken a hole in its top, and around the hole erected a chimney with which to connect his drain (Fig. 30). Often the hole into the sewer is much smaller than the drain which empties through it (Figs. 31 and 32). In such cases there are shoulders around the hole, on which solid matters accumulate.

FIG. 30

The sketches that have been given exhibit what until very recently has been the method, or rather lack of method, of making connections with the sewers of Boston; and it is supposed that the manner of doing such work elsewhere in the State has been very similar. In Boston there has been an improvement in this respect during the last three years. The Superintendent of Sewers, realizing how much the efficiency of his charge was impaired by the way in which house-drains were frequently connected with the sewers, obtained, against considerable opposition, authority to require that any future connections should be made under his inspection. His regulations require junctions to be made with slants and curves, as shown in Fig. 33; but, of the total number of existing drains, the proportion so connected is very small. Speaking generally, it may be said that almost all the drains in old Boston are defectively connected with the sewers they enter.

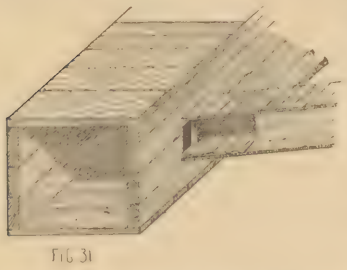

FIG. 31

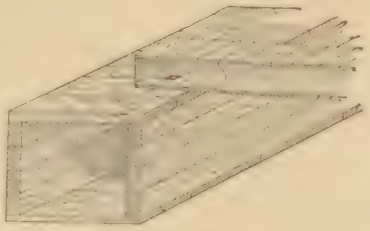

FIG. 32

The material of which a drain is composed should be durable, both on account of true economy, and, what is more important, because, being generally out of sight, any decay or failure in it is not readily discoverable. For the same reason that portion of the drain within the house should never be put where it cannot be easily examined in case there be any suspicion of trouble. The materials most generally used for drains are brick, stone, slate, vitrified clay, cement, wood, and iron.

Bricks made of good clay, thoroughly burnt all the way through, are among the most enduring of building materials.

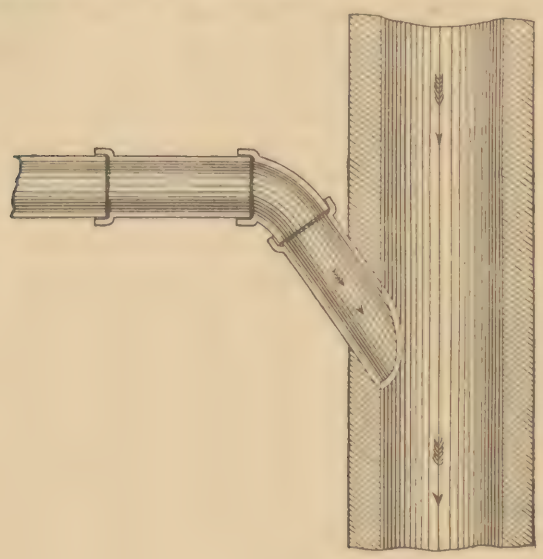

FIG. 33

But all bricks are not so enduring. From some kinds of clay good bricks cannot be made. In every kiln of bricks there are some which are not thoroughly burnt. A soft brick will rot and disintegrate in water. Therefore, while, as regards durability, bricks may be said to be a perfectly suitable material for drains, the statement is only true provided great care is used in selecting them. Building stone and slate, often used for the tops and bottoms of drains, are generally durable (though there are instances of slate disintegrating in the course of years); but there are other reasons why their use is not to be commended.

What has been said about bricks applies to the clay drain-pipe (now so commonly used), to a degree not usually recognized. Too frequently one hears Akron pipe spoken of as though it possessed unvarying qualities. It should be remembered that such pipes are burnt in a kiln very much as bricks are. Before burning they may be air-checked; like bricks, the pipes nearest the fire may be warped or fire-cracked; those higher up may be less thoroughly burnt, corresponding to "light-colored bricks." Others may be quite soft, and imperfectly glazed; or the glazing may scale off by "popping."

Slip-glazed pottery pipes are still more liable to defects. They are made of a different kind of clay, and, being burnt at a lower temperature, are usually more porous and less hard. The glazing, which is formed by dipping them before burning into a thin mixture of argillaceous earth, forms a skin over the pipe, which at times peels off under the action of frost, acids, or hard usage. While either kind of pipe, if well made, is durable enough, poor samples of each were occasionally noticed while constructing the intercepting sewer. It is important, that, in using them for house-drains, care should be exercised in their selection.

Without going into the vexed question of the comparative merits of clay and cement pipes, it is sufficient to say here of the latter, that while they can be, and often are, made so as to be very durable, yet cases where they have failed and disintegrated are frequently reported; and it is extremely difficult to judge from their appearance whether they are good or not. In resisting the action of acids and alkalies, they have been proved far inferior to well-burnt bricks or clay.

It is not easy to shape wood into the proper form for a drain. If it is always kept wet, as in the bottom of a drain constantly in use, it will last an indefinite time. Where it is alternately wet and dry, as in the sides or top of a drain, it is sure to decay sooner or later. Of those seen last year the report concerning many is, "rotten," "could not be held in place," "fell to pieces when handled," &c. The state of one such drain observed by the writer, in which the cover had partially rotted away, and earth fallen in, is given in Fig. 34. Unless there are exceptional conditions, the use of

wood for house-drains must be condemned on account of its liability to decay, as well as for other reasons.

The use of iron as a material for the construction of house-drains is of too recent date to permit of an absolute statement as to its durability. Thus far there seems little reason to doubt that it is suitable in this respect; and its many other merits will probably lead to its more extended use for this purpose.

Sanitary science, as it now exists, is of recent origin. Until within twenty years the arrangement and construction of sewers and drains were committed to mechanics and laborers, and were considered beneath the attention of educated men. Interest in the subject was first excited through the discovery by the medical profession, that a large class of diseases (thereafter called filth-diseases) was induced by the presence of gases arising from defective drainage.

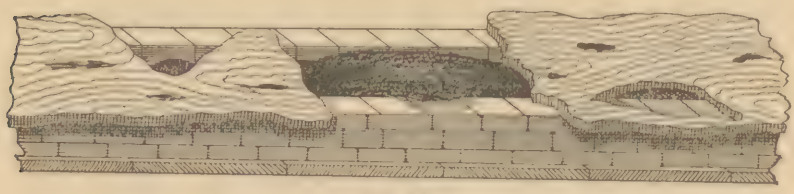

FIG. 34

To investigate and cure the inefficient methods and appliances which caused these gases, lay within the province of the engineer; and hence sanitary engineering and sanitary engineers came into existence. These latter devoted themselves with ardor to unearthing evils, and devising remedies for them. Like new brooms they attempted to sweep clean, and to purify at once the Augean stables they had discovered. But, like all reformers, they were sometimes carried away by their discoveries and theories; so that occasionally public opinion has re-acted against an exaggerated presentment of the evils of bad drainage. People have replied, "Nonsense! things cannot be in such a desperate condition, or the human race would have died out. Our fathers lived comfortably to a good old age without bothering their heads about drains, ventilators, or traps; and we are willing to take our chances."

It might be answered that our fathers did not have our

intricate apparatus for drainage to bother themselves about. Neither did they put on double windows, and ventilate their houses through their cellars, nor connect their drains with their sleeping-rooms, as we do. The writer has no wish to be an alarmist. The risk from sewer-gas is probably not so great as many suppose: it is a slight risk, but a slight risk of a terrible danger. If a man thinks there is no need of insuring his house, because his father lived in it for fifty years without a conflagration, he has a right to his opinion. What has been given in this paper, beside a few general principles, is a simple statement of what exists as seen by the writer and others. The question of plumbing has not been noticed, because the writer is not especially qualified to discuss it. He merely speaks whereof he knows; and the evidence is submitted without argument, for the consideration of those interested.

Should any one, admitting the evil, ask concerning a remedy, the answer is twofold. For the defective drainage which already exists, there can probably be no immediate radical relief: it can only come as people learn to appreciate the danger of sickness and the value of health. When householders become sufficiently interested to wish to know where and what their drains are, and to make a few investigations with bottles of peppermint and otherwise, then will the better day be at hand.

As to what may be done to prevent an increase of bad work, a suggestion is offered. It is safe to assume that every man who builds a house for himself desires that its drainage shall be fairly efficient: unfortunately it is not equally safe to assume that he will spend the time, thought, and money necessary to make it so. Now, since a defective house-drain may affect not only the owner of the house, and his family, and all who may thereafter reside there, but also the whole neighborhood, would it infringe on personal liberty too much, to require that the house-drain, if no more, shall be built according to approved plans and under municipal inspection? Merely to require that before beginning such work a plan of it should be put on record, would accomplish something. In drainage, to have *some* plan, even if a bad one, is better than none. It insures a little thought beforehand, a knowledge of the height of the sewer, and an adaptation of the drainage to it.

In Frankfort-on-the-Main, which has lately been sewered on the most perfect system and with the latest results of engineering skill, it was found impossible to realize the expected benefits unless some control was exercised over house-drainage. In that city, connection with the city-sewers is not compulsory; but if any one desires, as nearly all do, to drain into them, it is required that detailed plans in duplicate, showing every thing to be done, shall be filed, one with the board of works for its approval, and the other to be kept at the house. The whole work is done subject to its constant inspection of materials and workmanship.

In the Eighth Annual Report of the State Board of Health, January, 1877, pp. 130–132, are given the conditions under which buildings, &c., are allowed to be drained into the new sewerage system of Frankfort. The plans to be filed are referred to thus: —

"Whenever the drainage of any house, yard, &c., is projected, the owner of the property in question must, after having signed the requisite certificate, furnish to the department duplicate plans bearing the signature of the contractor, and containing a map of the locality on a scale of at least 1:2,500, a ground-plan at least 1:250, and a sketch of the main drain and branches with its horizontal plane on the same scale as the ground-plan, and its profile at least 1:125."

"The certificate and one of the duplicate plans are to be kept among the documents of the sewer department: the other plan must be always ready for inspection by the officers at the place for which it is designed."

"All plans presented must contain all the works projected: the exact position of sinks, gullies, traps, and other details; the direction of the superficial water-carriers; the positions of the rain-spouts, cisterns, privies, water-closets, cesspools, vaults, wells, pumps, and other arrangements for water supply; also the levels of the surface where the works are projected, including the grades of the latter, the depth of the cellar, the lowest levels of the ground, and, where possible, the depth of the foundations, — all to be given by the standard grade."

This preparation of plans is the pivotal point about which centres the whole regulation of private drainage. Its effect is probably, that, as the owner and mechanic are unable to make the plans with the requisite nicety and accuracy, they are prepared by an engineer familiar with the proper designing of such structures. It will be noticed that this filing of plans is not to be a mere form, but that a duplicate is to be kept on the ground to be constantly referred to in constructing the work.

The question of sewerage is forcing itself upon the attention of all our cities and towns. Boston has appropriated between three and four millions of dollars for a system of interception, whereby its sewers shall discharge freely at all times, and their contents be diverted from the vicinity of dwellings. It is the first, most important step, and, as the tax-payers realize, costs dearly. If the full benefit of this improvement is ever to be realized, it will only be when the house-drains and common sewers are rendered equally efficient, and the fundamental condition of perfect sewerage — an uninterrupted removal of waste matter from the house to its final place of deposit — is attained.